

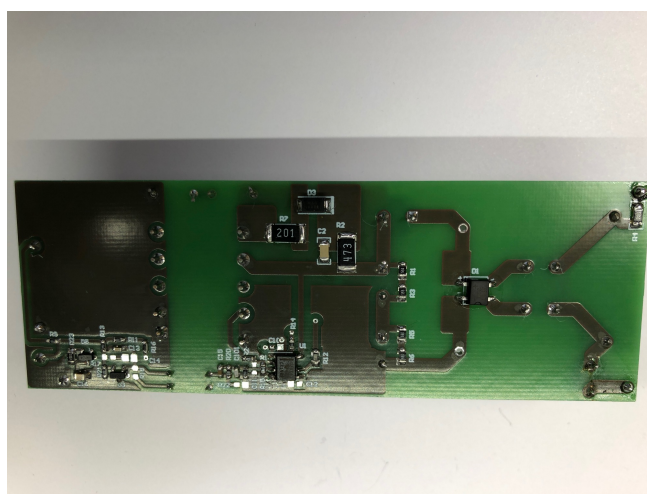
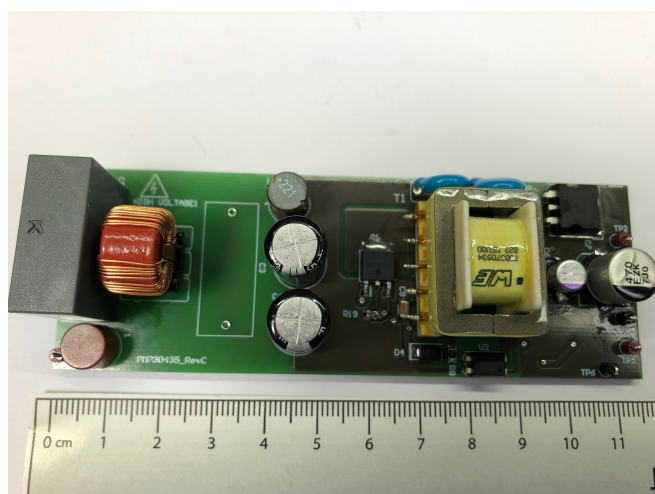
Test Report: PMP30435

156-VAC - 440-VAC Input magnetically resistant anti-tamper flyback reference design



Description

The PMP30435 is a tampering-protected power supply for smart meters using the UCC28740 valley switching flyback controller. An optimized circuit and transformer make the design robust against an external magnetic field of up to 200 mT. The test report shows the measurement results with and without the presence of an external magnetic field. A magnet (Neodym, N35, $B_r = 1.21$ T, 50 mm x 12.5 mm x 50 mm) was placed on the top of the transformer. The distance (D) between the transformer and magnet was 5 mm.



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1 Test Prerequisites

1.1 Voltage and Current Requirements

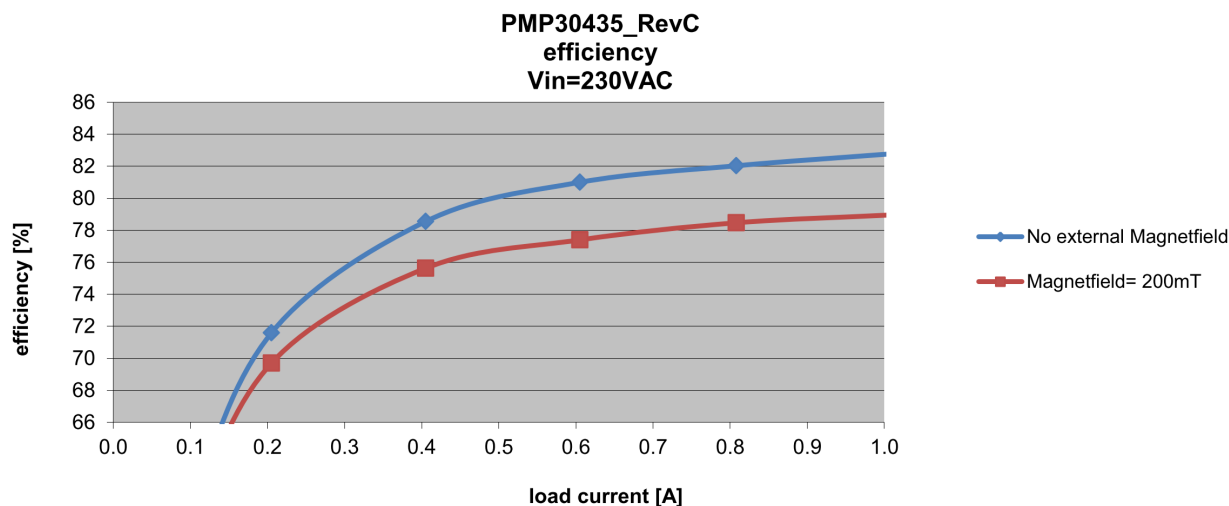
Table 1. Voltage and Current Requirements

PARAMETER	SPECIFICATIONS
V_{IN}	156VAC - 440VAC
V_{OUT}	12V@1.0A
Nominal switching frequency	45kHz

2 Testing and Results

2.1 Efficiency Graphs

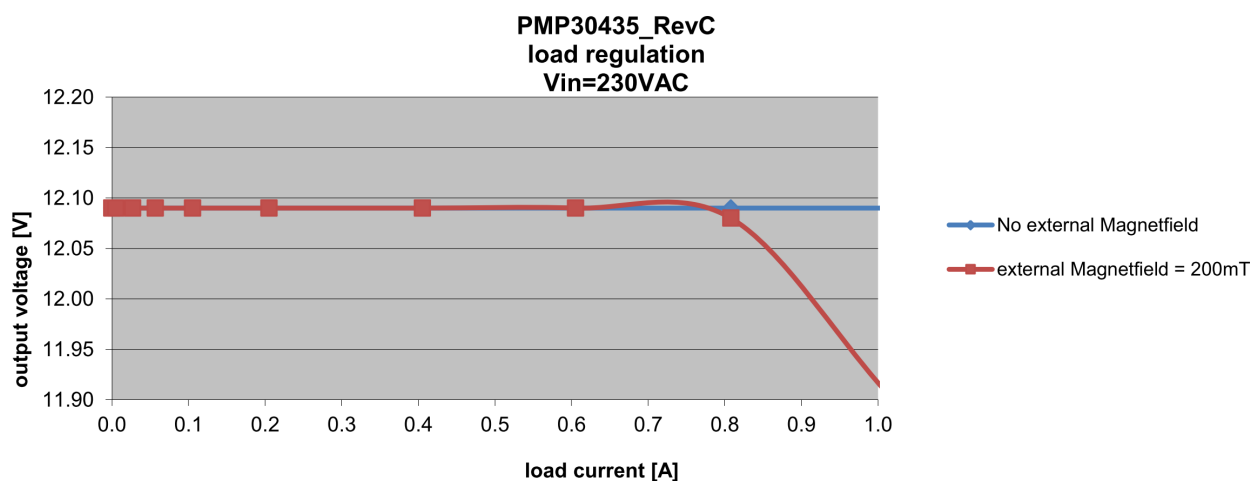
Figure 1. Efficiency



Input Voltage = 230VAC

2.2 Load Regulation

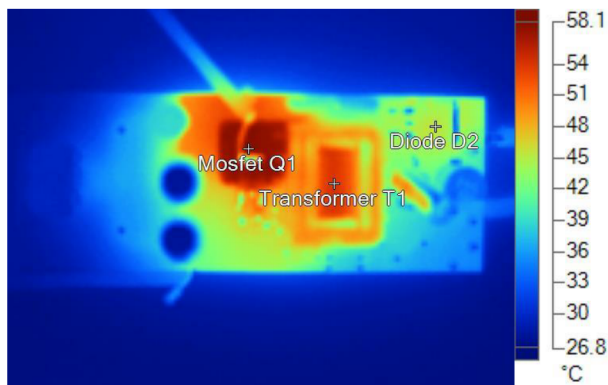
Figure 2. Load Regulation



Input Voltage = 230VAC

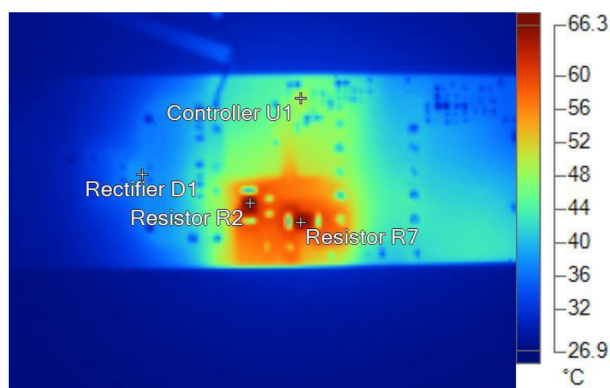
2.3 Thermal Images

The following images show the infrared images taken from the FlexCam after 15 minutes at full load output power without an external magnetic field.

Figure 3. Thermal Picture Top Side

Vin=230VAC Iload=1A Top

Name	Temperature	
Transformer T1	54.1°C	
Mosfet Q1	58.1°C	
Diode D2	45.4°C	

- Input Voltage = 230VAC
- Load Current = 1.0A
- Ambient Temperature = 25°C
- No heatsink, no airflow

Figure 4. Thermal Picture Bottom Side

Vin=230VAC Iload=1A Bottom

Name	Temperature	
Rectifier D1	38.4°C	
Resistor R2	66.3°C	
Resistor R7	65.8°C	
Controller U1	49.4°C	

- Input voltage = 230VAC
- Load Current = 1.0A
- Ambient Temperature = 25°C
- No heat sink, no airflow

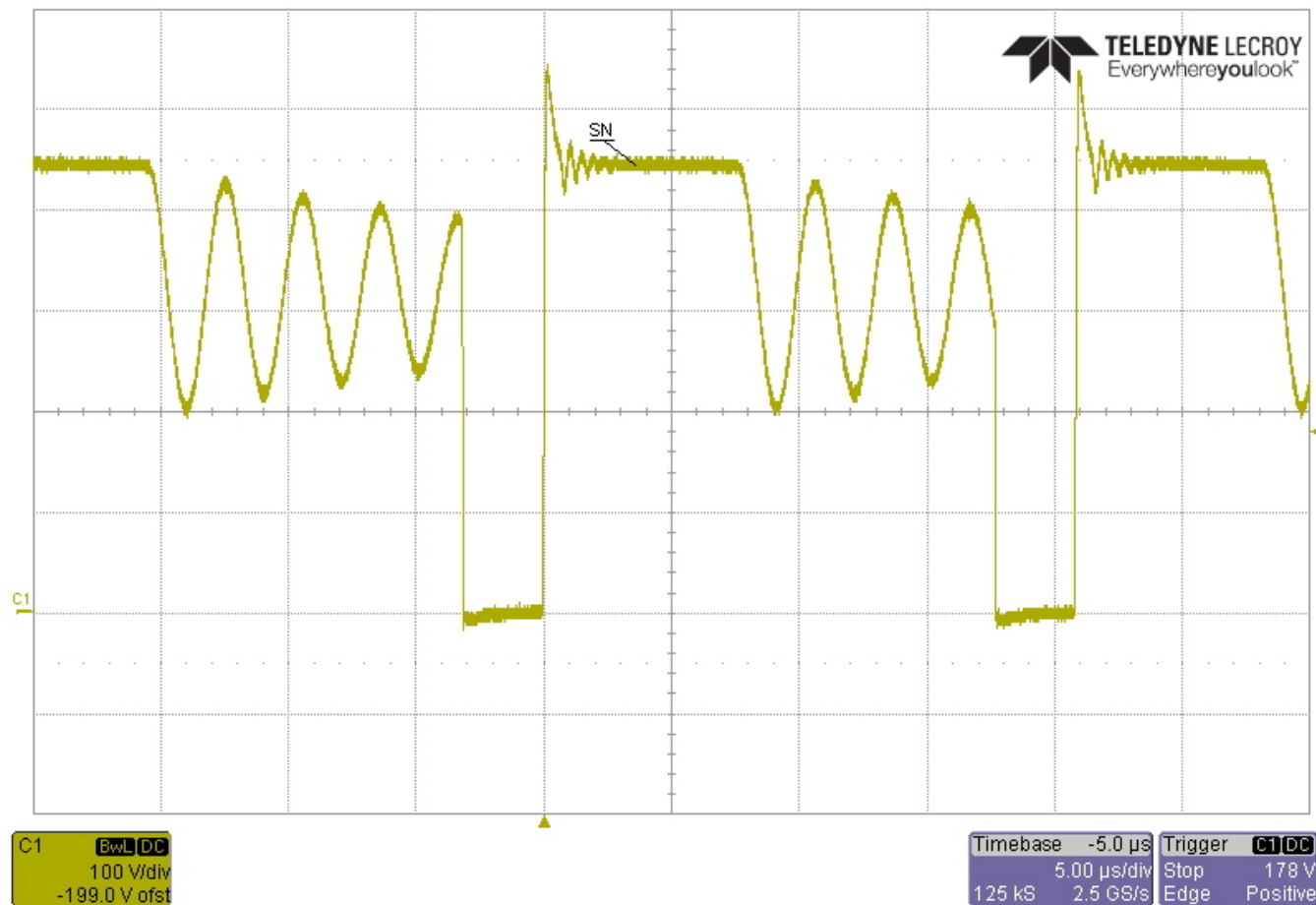
2.4 Dimensions

115mm x 40mm

3 Waveforms

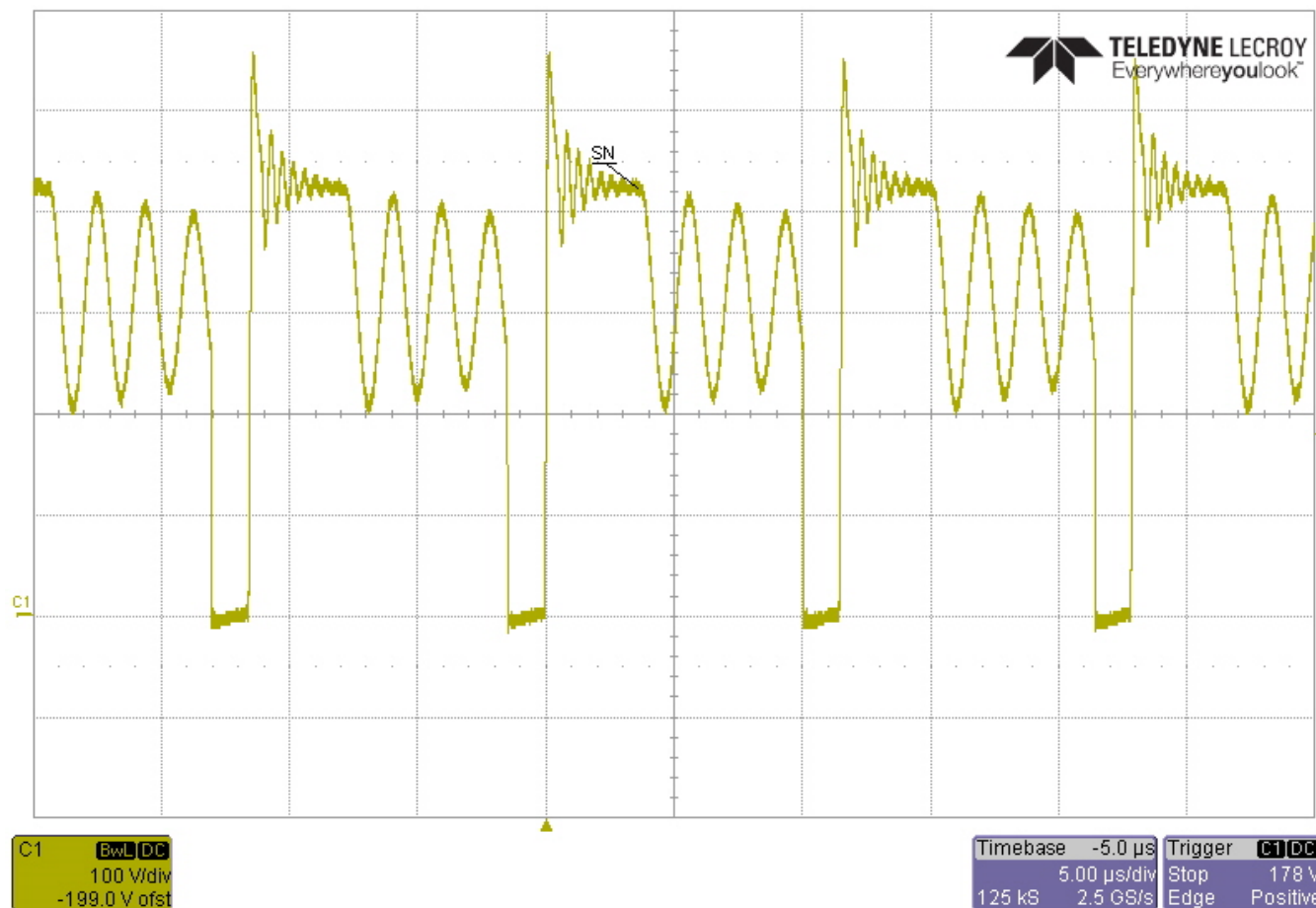
3.1 Switching

Figure 5. Switchnode



- Input Voltage = 230VAC
- Load Current = 1.0A
- External Magnetic Field = 0mT

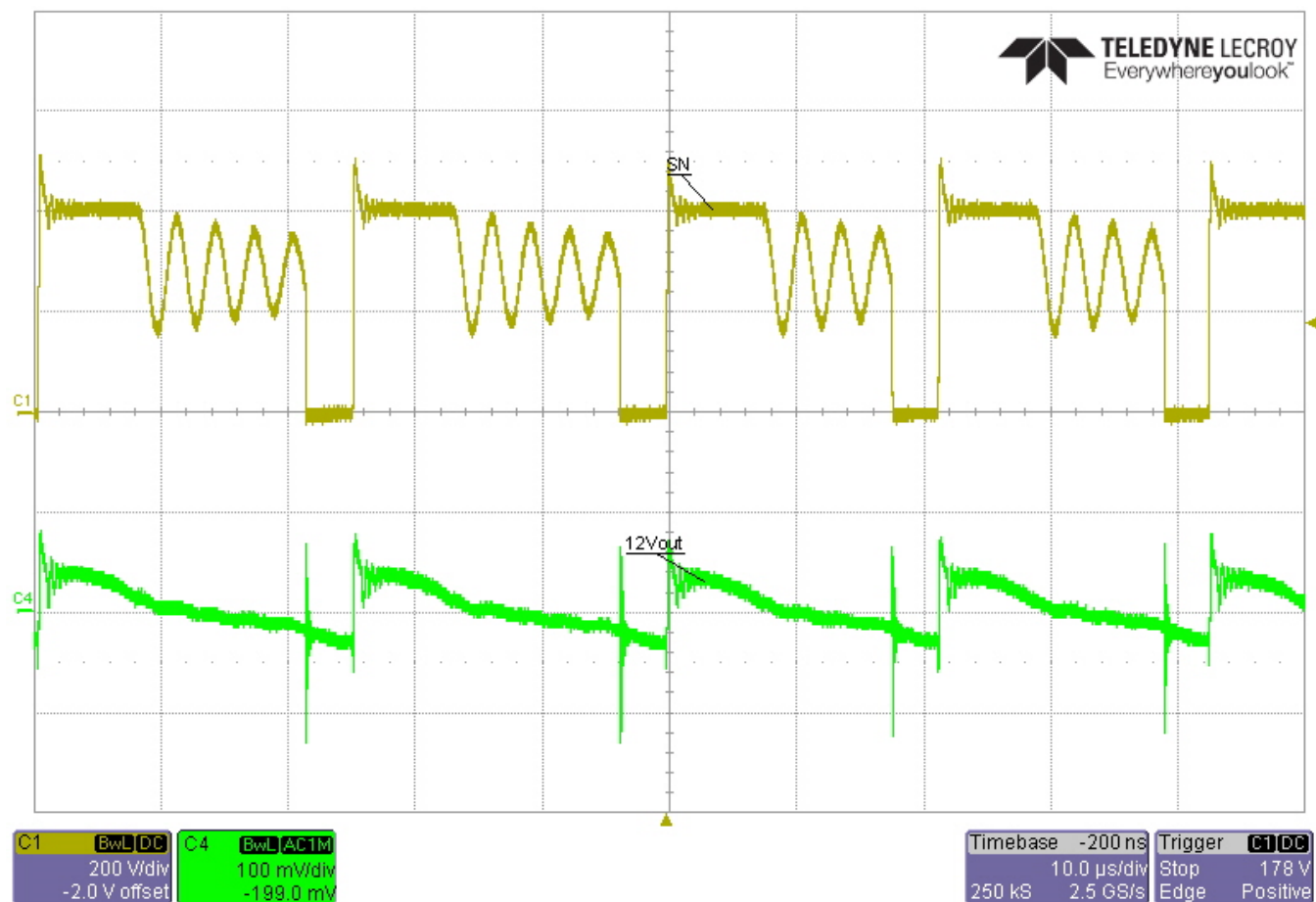
Figure 6. Switchnode



- Input Voltage = 230VAC
- Load Current = 1.0A
- External Magnetic Field = 200mT

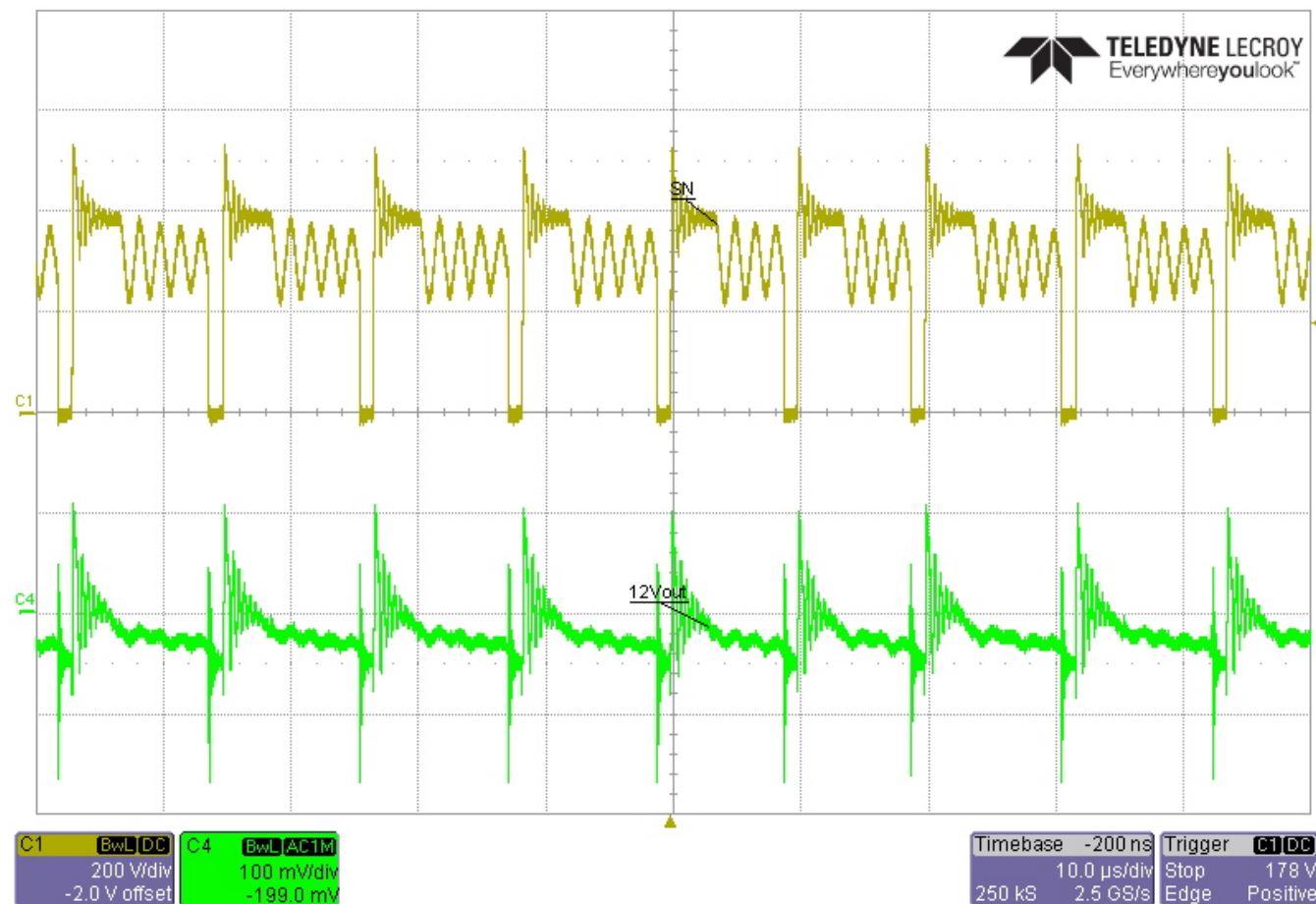
3.2 Output Voltage Ripple

Figure 7. Output Ripple



- Input Voltage = 230VAC
- Load Current = 1.0A
- External Magnetic Field = 0mT

Figure 8. Output Ripple



- Input Voltage = 230VAC
- Load Current = 1.0A
- External Magnetic Field = 200mT

3.3 Short Circuit/Overload without external Magnetic Field

Output Voltage	Load Current
12.09V	1.21A
12.09V	1.26A
11.37V	1.27A
10.52V	1.27A
8.66V	1.28A
7.58V	1.28A
0.43V	0.22A

- Input Voltage = 230vAC
- Load Current 1.0A
- External Magnetic Field = 0mT

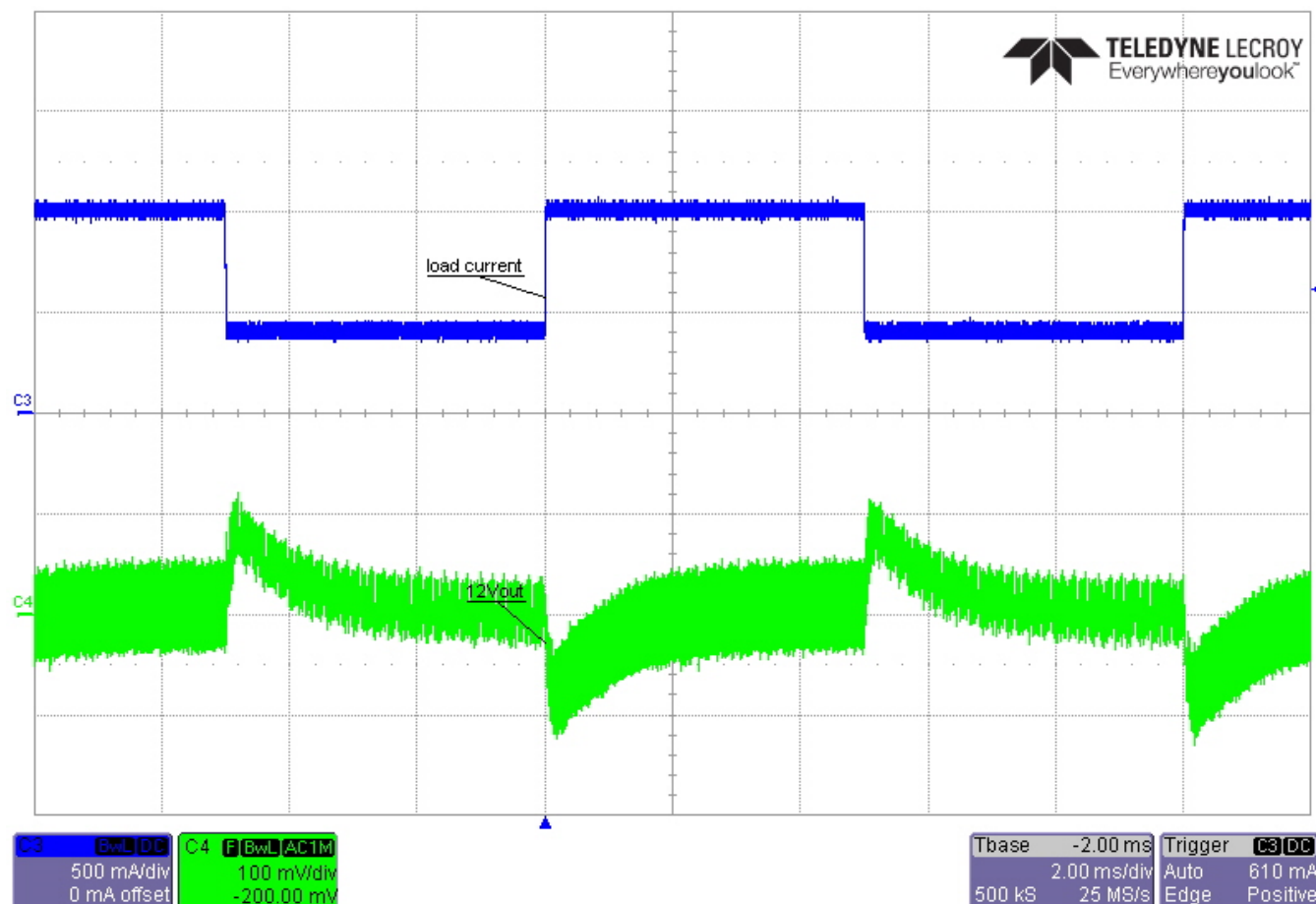
3.4 Short Circuit/Overload with external Magnetic Field

Output Voltage	Load Current
10.79V	1.11A
10.00V	1.20A
9.11V	1.32A
8.46V	1.32A
4.85V	1.33A
3.82V	1.33A
3.55V	1.42A

- Input Voltage = 230VAC
- Load Current = 1.0A
- External Magnetic Field = 200mT

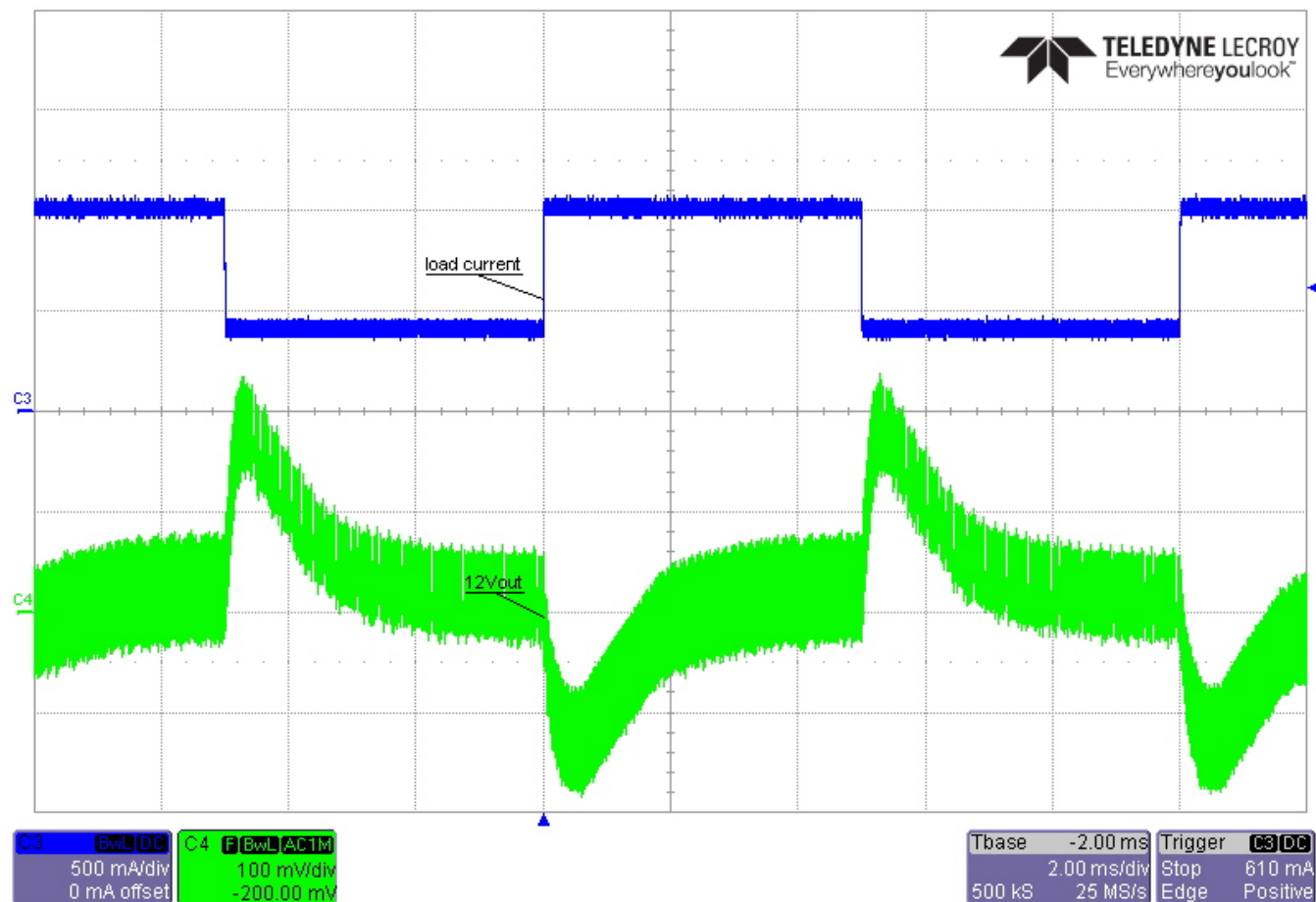
3.5 Load Transients

Figure 9. Loadstep 0.4A - 1.0A



- Input Voltage = 230VAC
- Load Current = 0.4A - 1.0A
- External Magnetic Field = 0mT

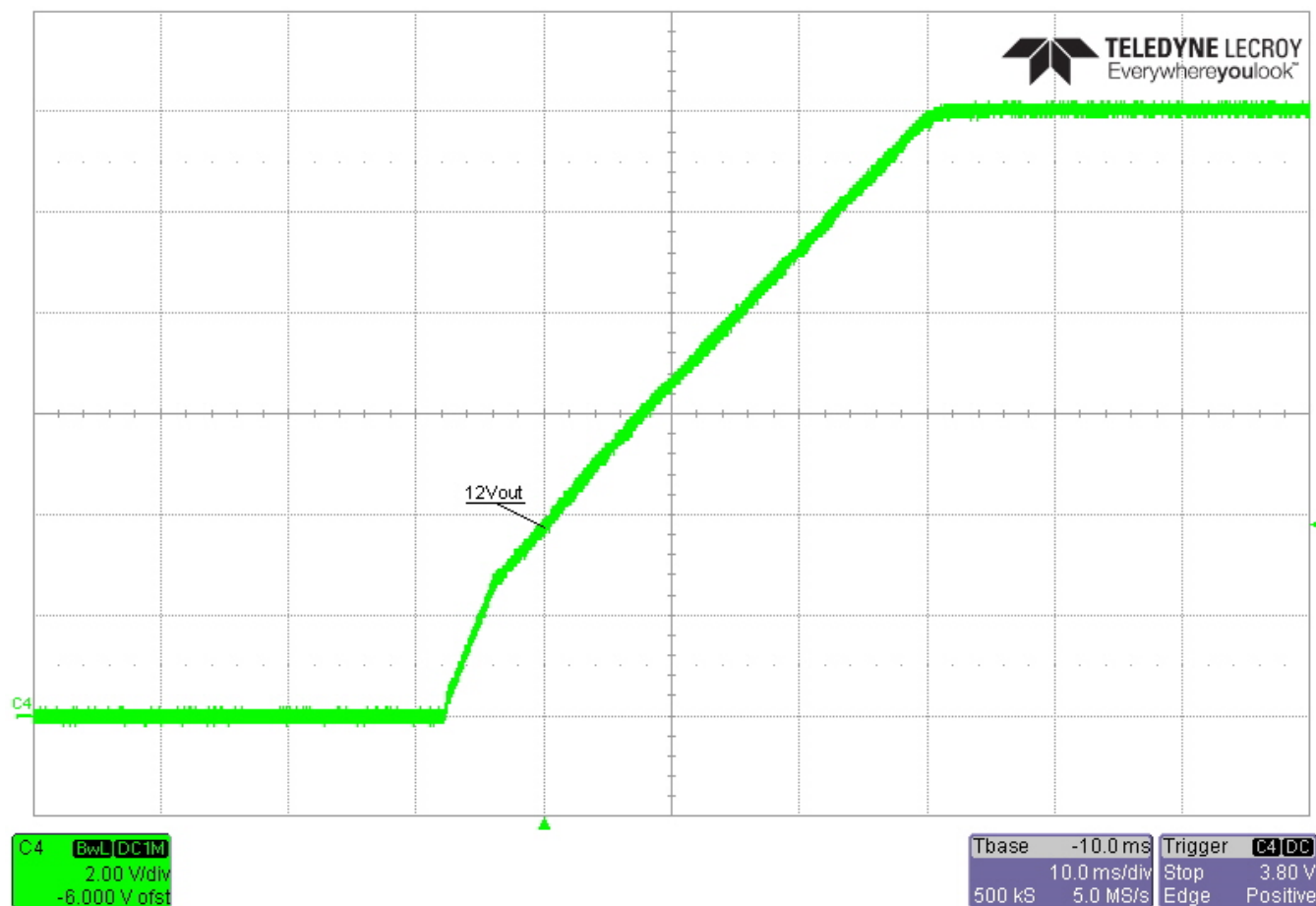
Figure 10. Loadstep 0.4A - 1.0A



- Input Voltage = 230VAC
- Load Current = 0.4A -1.0A
- External Magnetic Field = 200mT

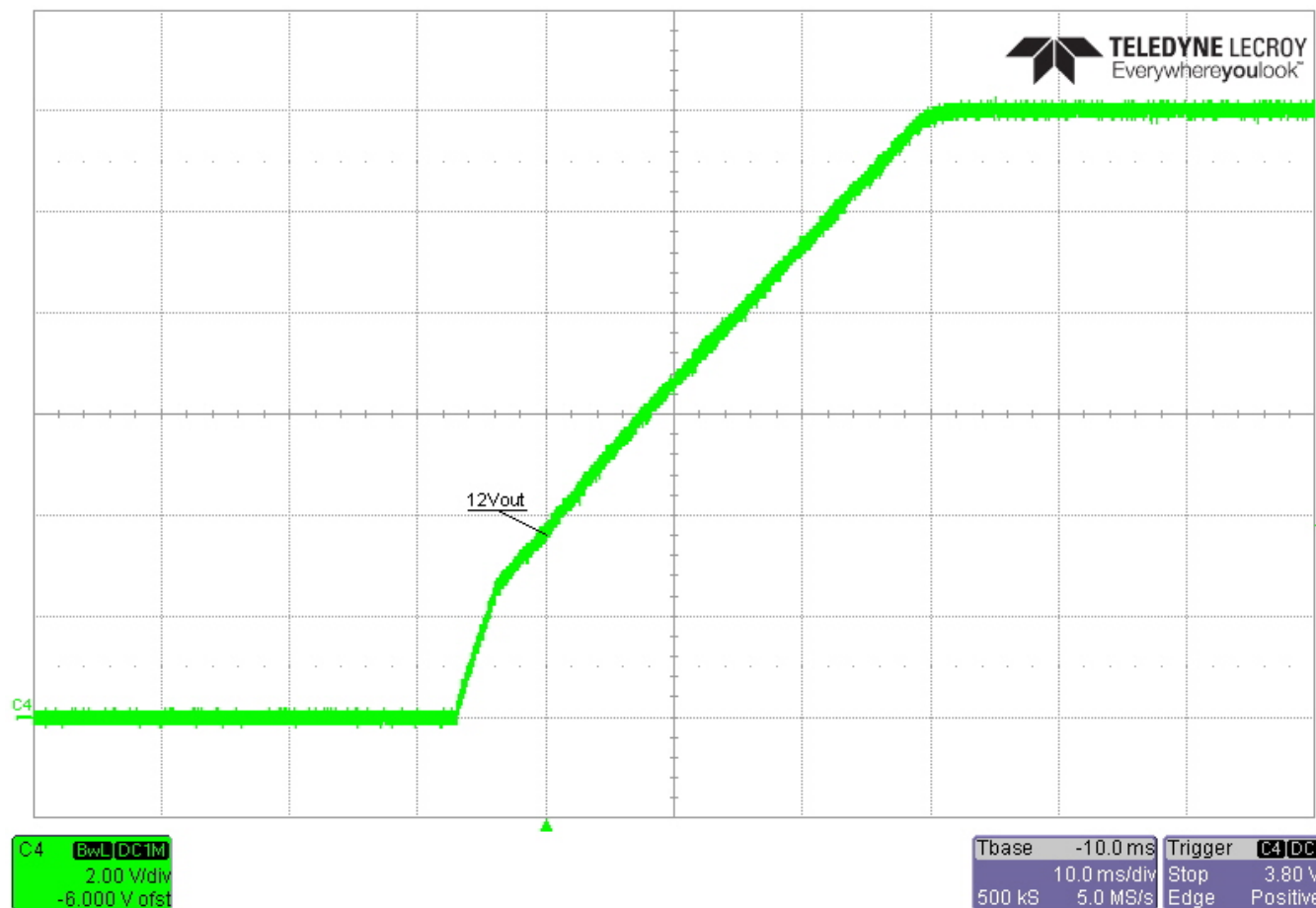
3.6 Start-up without external Magnetic Field

Figure 11. Startup Full Load



- Input Voltage = 156VAC
- Load Current = 1.0A
- External Magnetic Field = 0mT

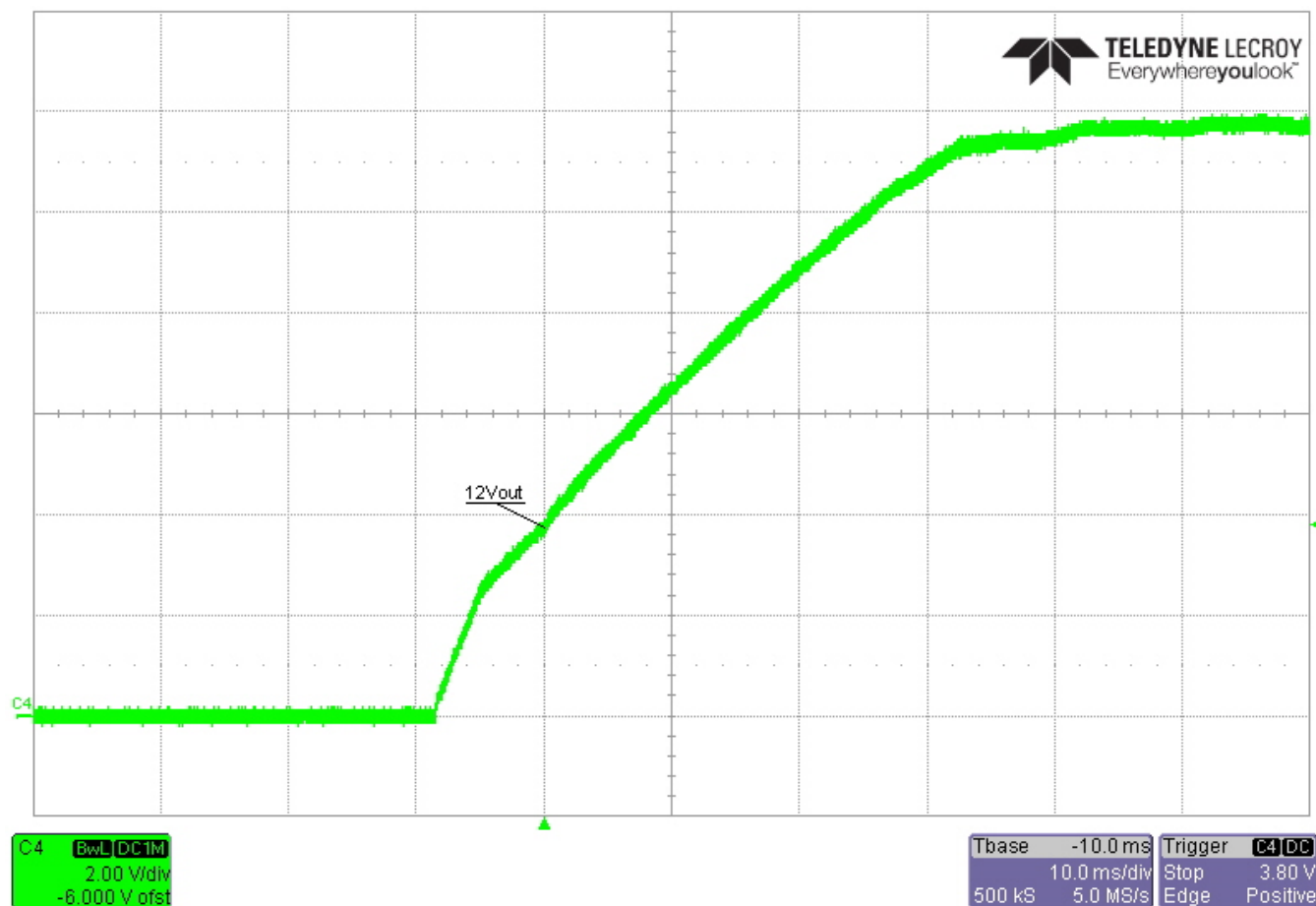
Figure 12. Startup Full load



- Input Voltage = 623VDC
- Load Current = 1.0A
- external Magnetic Field = 0mT

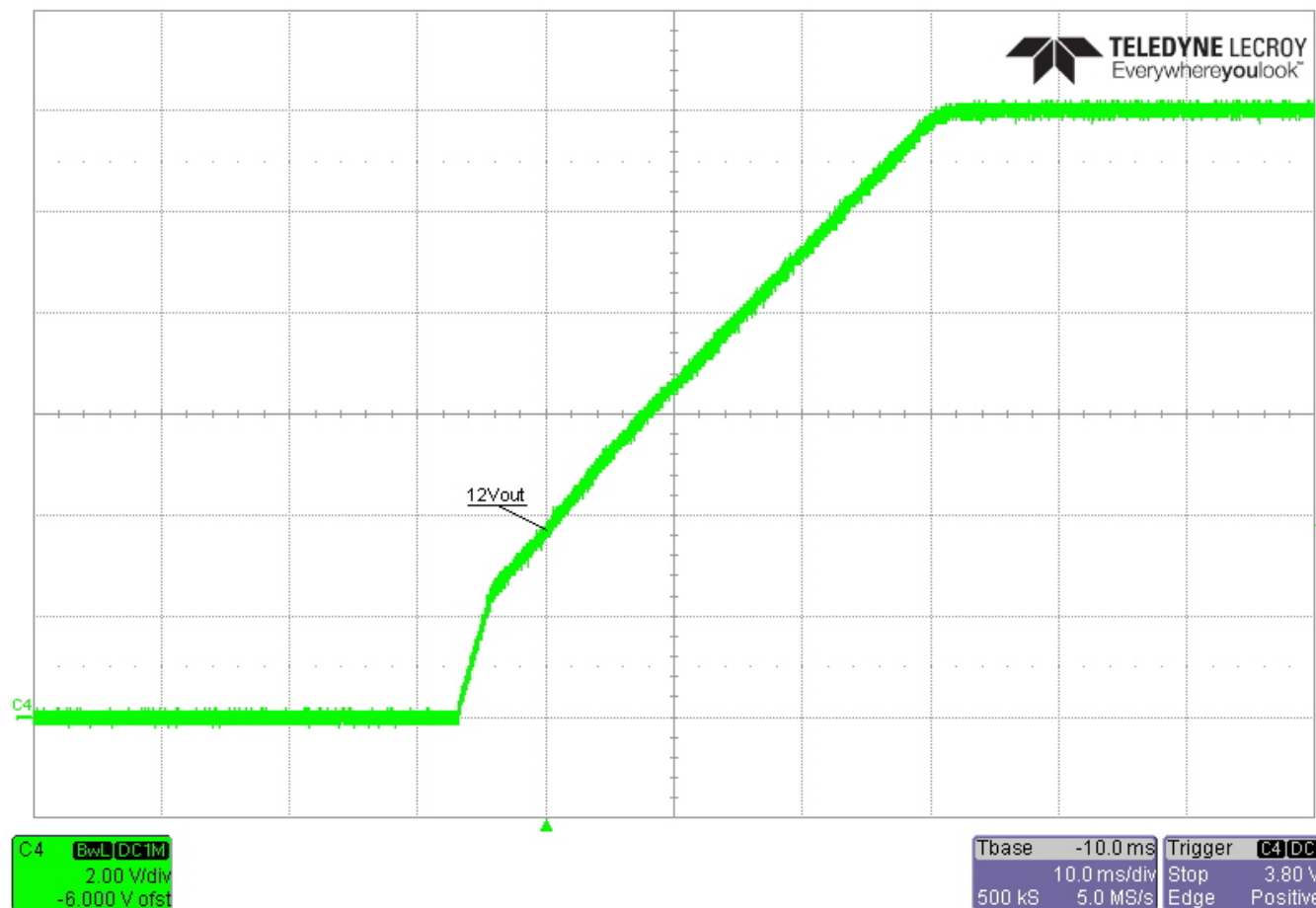
3.7 Start-up with 200mT external Magnetic Field

Figure 13. Startup Full Load



- Input Voltage = 156VAC
- Load Current = 1.0A
- external Magnetic Field = 200mT

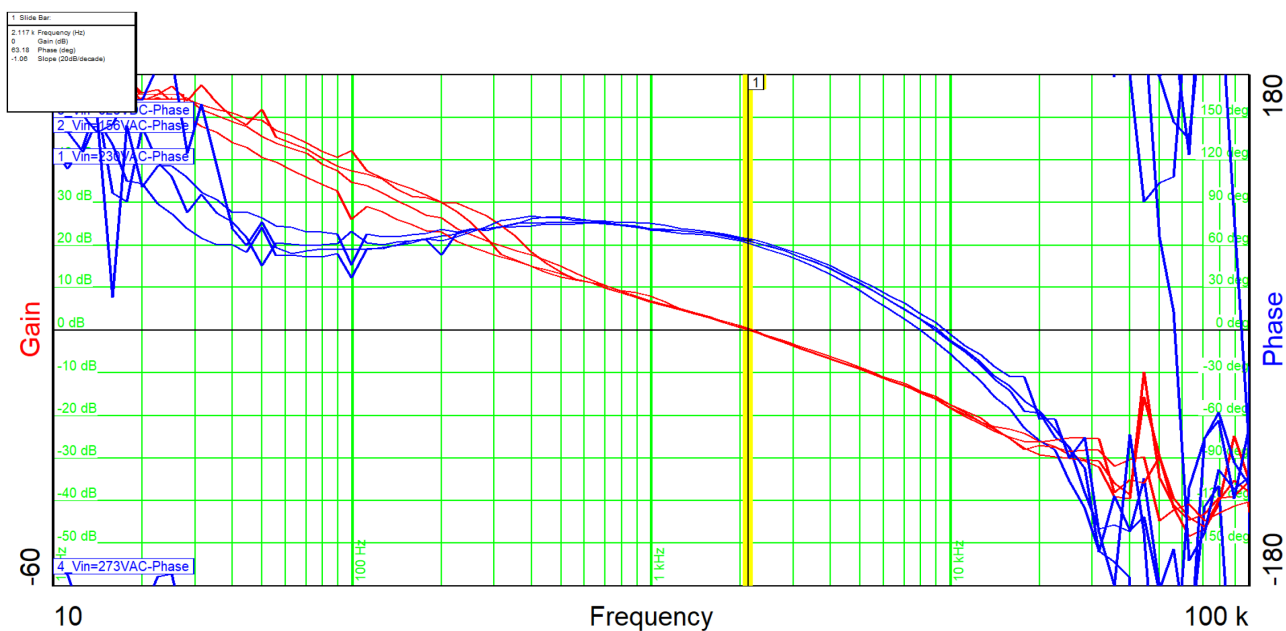
Figure 14.



- Input Voltage = 623VDC
- Load Current = 1.0A
- external Magnetic Field = 200mT

3.8 Control Loop Gain and Stability

Figure 15. Total Open Loop (Full Load) without external Magnetic Field

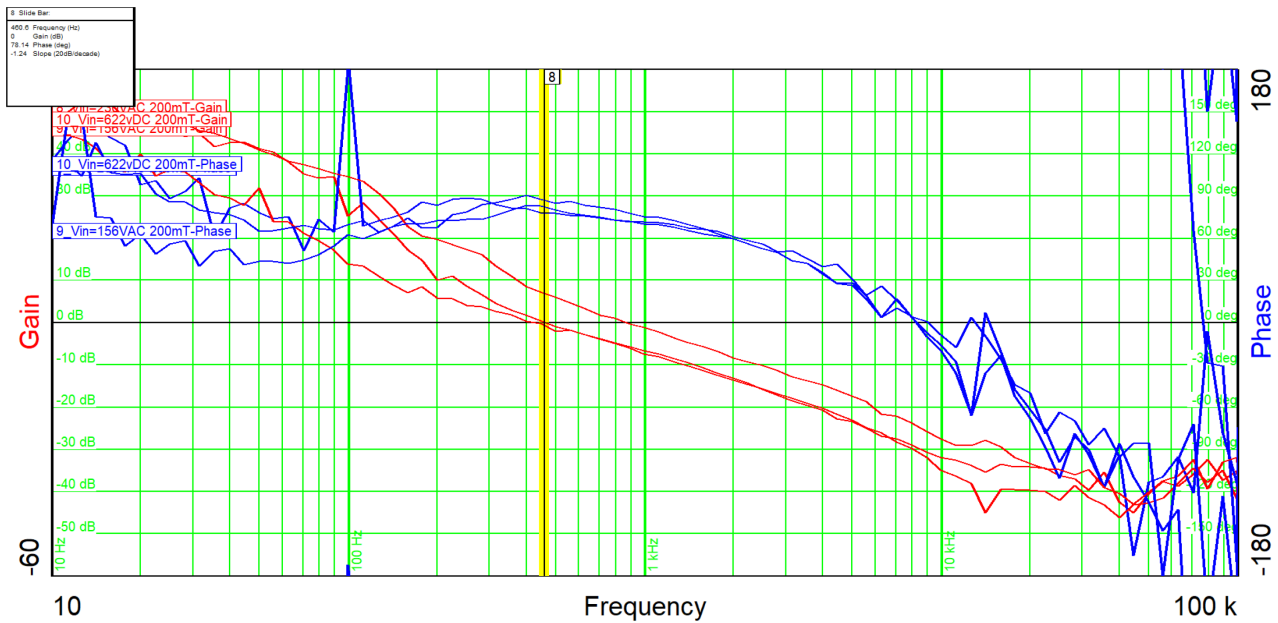


Input Voltage	156VAC
Load Current	1.0A
Bandwidth	2.1kHz
Phase Margin	61.0°

Input Voltage	230VAC
Load Current	1.0A
Bandwidth	2.1kHz
Phase Margin	63.1°

Input Voltage	623VDC
Load Current	1.0A
Bandwidth	2.2kHz
Phase Margin	63.6°

Figure 16. Total Open Loop (Full Load) with 200mT external Magnetic Field



Input Voltage	156VAC
Load Current	1.0A
Bandwidth	0.42kHz
Phase Margin	88.9°

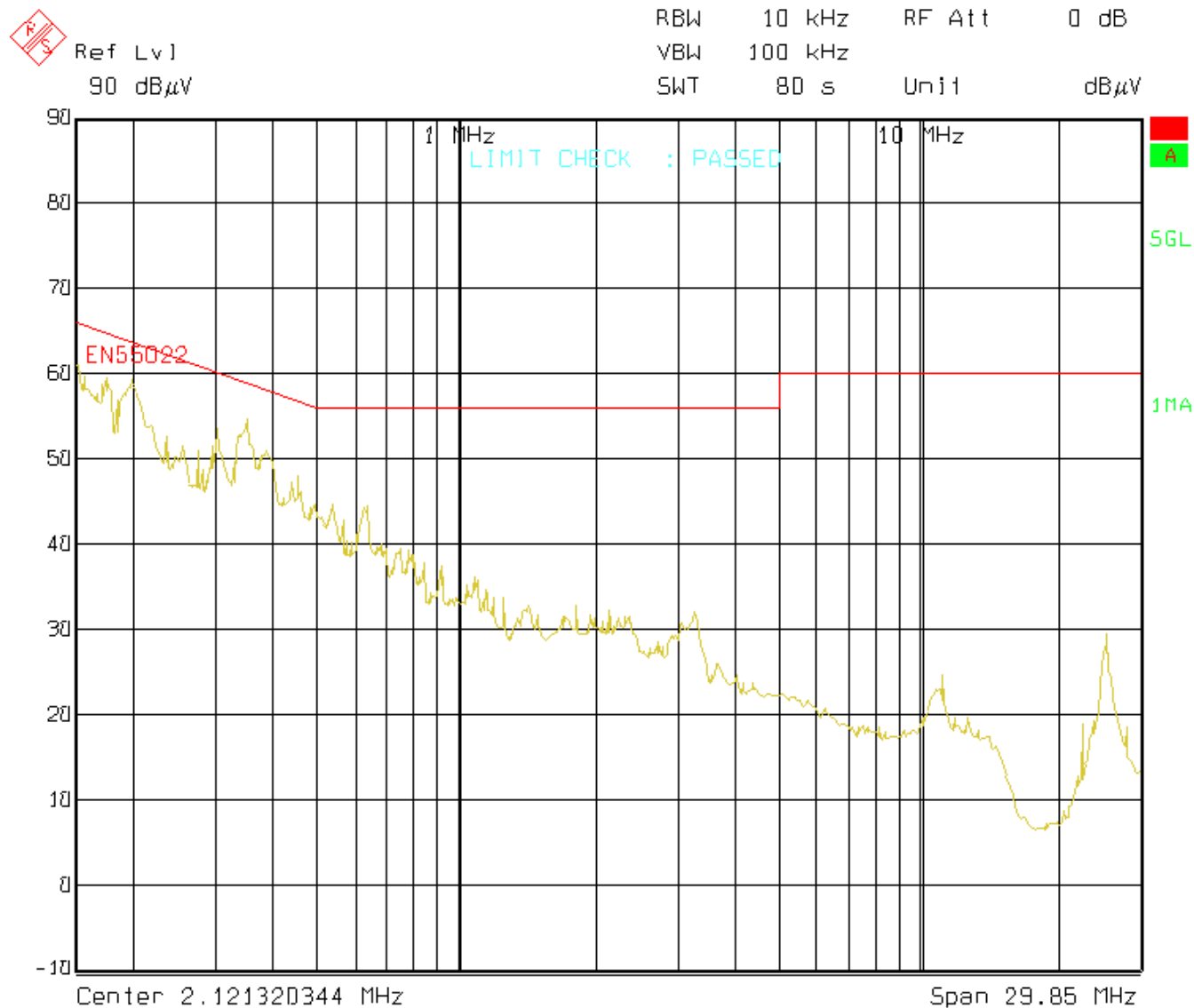
Input Voltage	230VAC
Load Current	1.0A
Bandwidth	0.46kHz
Phase Margin	78.1°

Input Voltage	623VAC
Load Current	1.0A
Bandwidth	0.87kHz
Phase Margin	71.7°

3.9 EMI Measurement

The graph below shows the conducted emission EMI noise and the EN55022 Class-B Quasi- Peak limits (measurement from the worst case line). The measurement is not certified. The board was connected to a LISN and an isolation transformer; the load was a power resistor. The receiver was set to Quasi-peak detector, 10 KHz bandwidth. The negative terminal of the converter has been connected to the ground of the LISN.

Figure 17. EMI



Date: 1.JAN.1997 0:07:08

- Input Voltage = 230VAC
- Load Current = 1.0A
- external Magnetic Field = 0mT

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